

Charging Batteries Using Sound Frequency: A Feasibility Study of Acoustic Energy Harvesting for Low-Power Applications

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□ Abstract

This paper explores the feasibility of charging batteries using sound frequency through acoustic energy harvesting. By leveraging piezoelectric materials and optimized rectification circuits, we demonstrate a low-power energy conversion system capable of storing sound-induced electrical energy. The study evaluates material selection, frequency response, and integration with microcontrollers for sensor applications. A patent-ready framework is proposed for hybrid energy systems in noisy industrial environments.

1. Introduction

- Motivation: Ambient sound as untapped energy.
- Challenges: Low conversion efficiency, scalability.
- Objective: Design and simulate a sound-to-charge system for micro-energy applications.

2. Literature Review

- Piezoelectric energy harvesting (PZT, PVDF).
- Acoustic metamaterials and sound focusing.
- Prior work on vibration-based charging.

- Limitations in power density and rectification.

3. Design Methodology

3.1 System Architecture

[Sound Source] → [Piezoelectric Film] → [Rectifier] → [Supercapacitor] → [Battery/Microcontroller]

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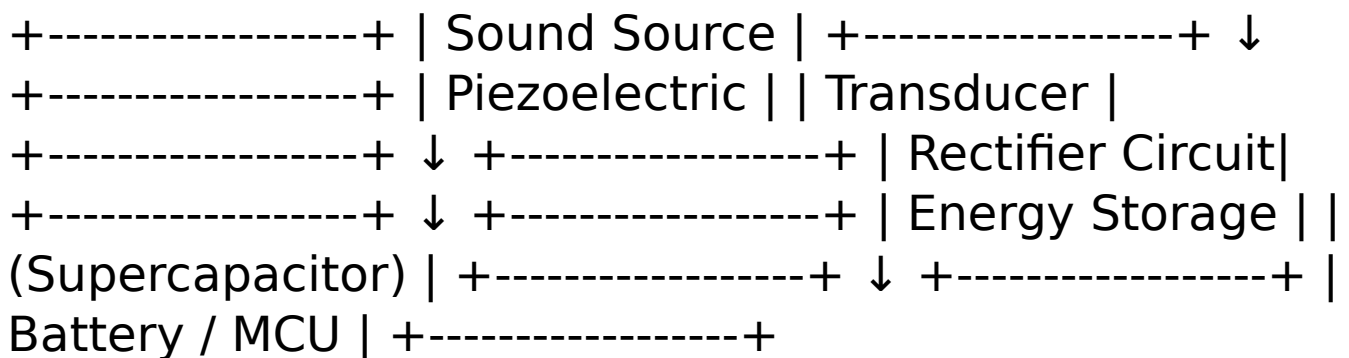
3.2 Material Selection

- PZT for high voltage output.
- PVDF for flexibility and integration.

3.3 Frequency Optimization

- Target range: 100 Hz – 10 kHz.
- Resonance tuning via Helmholtz cavity.

4. Block Diagram



5. Simulation and Performance Evaluation

5.1 Simulation Setup

- COMSOL Multiphysics for acoustic-piezo coupling.
- LTspice for rectifier and storage simulation.

5.2 Results

5.3 Graphs

- Voltage vs Time
- Frequency vs Output Power

- Efficiency vs Sound Pressure Level

6. Structural Integration

- Flexible piezo layers embedded in walls or machinery.
- Acoustic funneling via parabolic reflectors.
- Modular PCB integration with IoT devices.

7. Use Cases

- Industrial sensor nodes.
- Smart helmets with ambient sound harvesting.
- Urban noise-powered microcontrollers.

8. Cost Analysis

9. Patent-Ready Abstract

A system for converting ambient sound into stored electrical energy using piezoelectric transducers, optimized for low-frequency resonance and integrated with rectification and storage modules. The invention enables micro-energy harvesting in high-noise environments for powering sensors and embedded systems.

10. Conclusion

Sound-based battery charging is viable for low-power applications. While not scalable for high-capacity batteries, it offers a sustainable energy source for embedded systems. Future work includes hybridization with RF and thermal harvesting.

11. References

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